Values of Traffic Information on Variable Message Sign

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ABSTRACT

Since 1997, the metropolitan and major cities have actively built up Intelligent Transportation System (ITS) in Korea. But there was no any definite guideline to judge the economy of ITS so far. This research is begun under this background and focus the value of real-time traffic information on VMS.

This research estimates the value of real-time traffic information on VMS using Contingent Valuation Method (CVM) with Double Bounded Dichotomous Choice Question. The analysis is based on interview survey data from Dec. 3 to 15, 2007 during two weeks on national highways in the Seoul metropolitan area in Korea. The data reveals that the value of VMS information varies by user groups (age, gender, income, etc) and the level of congested conditions of national highways.

The results reveals that the value of real-time information on VMS should be included in the process of evaluating economic feasibility of ITS since the provision of real-time traffic information on VMS is the core service of ITS on national highways, and helping to improve efficiency of road networks.

1. INTRODUCTION

The Intelligent Transportation Systems (ITS) in Korea went stimulated after the ITS World Congress held in Seoul in 1998. The Model Deployment Initiative of 4 cities was implemented in 2002, and now, not only the numerical scale of the ITS service but related institutions have reached maturity. Especially among the 7 ITS services in Korea, Traffic Information Service and optimized transportation management service have been implemented as a leading role in supplying ITS services in major cities of Korea. As the core of ITS service, Variable Message Sign (VMS) which provide traffic information, had been installed nationally total by about 2,000. In detail, 345 VMSs in expressways (intellectualized section 3,000km), 355 VMSs in national highways (intellectualized section 1,500km) and 197 VMSs in city expressways in Seoul are being operated.

Real-time traffic information on VMS has various effects, which may induce the saving of travel time, fuel consumption, CO2 emission, and others by making traffic on the original road detour to other way (better conditioned road). In addition of above effects, the information gives traveller in trip another benefit. Whatever drivers who get the traffic information from VMS decide to detour their route or not, it lend emotional stability to them by being aware of the front traffic condition through traffic information on VMS. Therefore it is reasonable that the real-time information on VMS has some value even though it is not of great value.

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Suppose that you were stuck in the road due to traffic jam by a sudden accident or nasty weather and no information for faced condition had been given, you would lose your temper, confused. But if any information for why traffic jam occur or when traffic jam is cleared is given to you, you will feel more stabilized than in case of no information, and also you may clearly come to know how to cope with faced condition rationally (for example calling to postpone or cancel your appointment). Just like considerable opposite scenarios (no traffic jam on way etc.), information can makes drivers keep their composure all through the trip.

To describe the effect which drivers are able to get from traffic information on VMS, this study employed the term '***Escape effect from vagueness***', which means the subject effect that individual drivers in trip can get from information for the front traffic condition. But unfortunately the effectiveness of such information on VMS has been never evaluated, because the value has been thought to be uncountable. This makes decision-makers who think quantitative output of certain public investment to be most important embarrassed. The needs to demonstrate quantifiable effect for that value is increased.

Under this backdrop the intent of this paper is to provide the methodological approach that is appropriate to evaluate the value of traffic information on VMS and the results for this. The paper begins by over viewing methodology review. Attention is then directed toward design of questionnaire for Contingent Valuation Method (CVM) and survey. This is followed by estimation results of the value of traffic information on VMS. The paper concludes with a summary and direction for future research.

2. METHODOLOGY REVIEW

There are a number of techniques that have been used in the contingent valuation approach to estimate the non marketed value. This paper considered Contingent Valuation Method (CVM) as a method of estimating the non market value such as traffic information on VMS through the literature review.

The CVM has originally been used to estimate economic values for all kinds of eco-system and environmental services but it also can be used to estimate both use and non use values, and it is the most widely used method for estimating non-use values. CVM is the most controversial of the non-market valuation methods. In CVM, these values are generally measured based on the willingness to pay (WTP) for improved environment or the willingness to accept (WTA) compensation for damaged environment or to accept a condition of being deprived of the improved environment. The most appealing aspect of the CVM is that it allows us to estimate total value rather than components of that total value (Frykblom, 1997).

The benefits suggested in this paper would be extrapolated from information preference. This paper may show that how much the value of traffic information on VMS would be and then how it would be translated into the benefits at the ITS business. For this purpose of this paper, we would discuss three valuation techniques that are currently practiced in non marketed valuation of environmental goods (in other word the public goods): the direct costing technique, revealed demand

and bidding game. The direct costing technique is a method of estimating the non marketed benefit of reduced environmental damage based on direct estimate of the cost invested to recover that damage. This costing technique is practically challenging. Unavailability of information, pricing and accounting problems inherent in the analysis has made it difficult to put the method into widely use. It would be even more difficult if you are trying to apply this technique in the valuation of aesthetic environmental improvement, since the cost of aesthetic damage is not explicitly reflected in the market (Randal et al, 1974). Originally, the direct costing technique has seen practiced in flood control projects where there was the strong requirement of the benefit and cost analysis of building any physical structure such as dams or reservoirs to prevent residential and agriculture lands from flooding. Before making a decision whether to implement flood control projects which would, on the one hand very costly to the society and on the other, would impact on the ecosystem; the cost-benefit analysis (CBA) was conducted. In calculating the benefit and cost of the projects, the direct cost technique has been used. The technique allowed for the estimate of the cost of damage to crops and residential properties and other inherent costs such as cleaning up cost, rehabilitation, resettlement costs and so on (Kneese, 1984).

Secondly is the revealed demand. In the case of reduced air pollution, the revealed demand for residential land is related to the concentration of air pollution (Randal et al, 1974). Here, authors assume there are two houses that are very similar in everything except location, as one is located close to the airport, and the other is located in very peaceful and quiet environment. Could you guess which one would be more expensive? The price of the house close to the airport must, of course, be lower than that of the other which is not; unless you enjoy noisy environment or enjoy watching airplanes taking off and landing. From this example we can see a difference in price of these very similar houses. If the house were not located close to the airport, it would have the same price. In other word, if the noise pollution is abated, the benefit from that abatement would be the price difference.

Finally the bidding game is also a technique of estimating the non market benefit of improved environmental quality or establishment of recreation sites. Through this method the respondents will be asked “to answer YES or NO to the question: would you continue to use this recreation area if the cost to you was too increased by X dollars? The amount is varied up and down in repetitive question; the highest response will be recorded. Demand curve for recreation services is generated through the aggregated individual responses (Randal et al, 1974, p.443)”. In a simple sense, the bidding game would ask the respondents to react to varying bids. The bids will be raised or lowered until the respondents switch their reaction from the point of inclusion to exclusion. In order to make the response more reliable and stable, the respondents must be the consumers of the product rather than the potential ones. The technique becomes more dependable if the survey is conducted at the recreation sites where respondents are currently engaged in the activity (Knetsch and Davis, 1966). There are several questions that have been used both in a control experiment and in practice. Among those are dichotomous, open ended, payment card and bidding game. This paper designed questionnaire as a form of bidding game. Dichotomous choice is a bid offered to the respondent that he/she can accept or reject, while in the open-ended question the respondent is, on the other hand, asked for his or her maximum willingness to pay for something that are of his or her most interest, in

this case, the improved quality environment. Payment card is another mode of question used in contingent valuation. The card is shown to the respondent with several bids printed on it. The respondent is asked if any of those bids is close to his/her maximum willingness to pay. And the bidding game is refereed to the sequence of bids offered to the respondent so that his or her maximum (or minimum) willingness to pay can be elicited." (Frykblom, 1997).

The process of this study is like as figure 1.

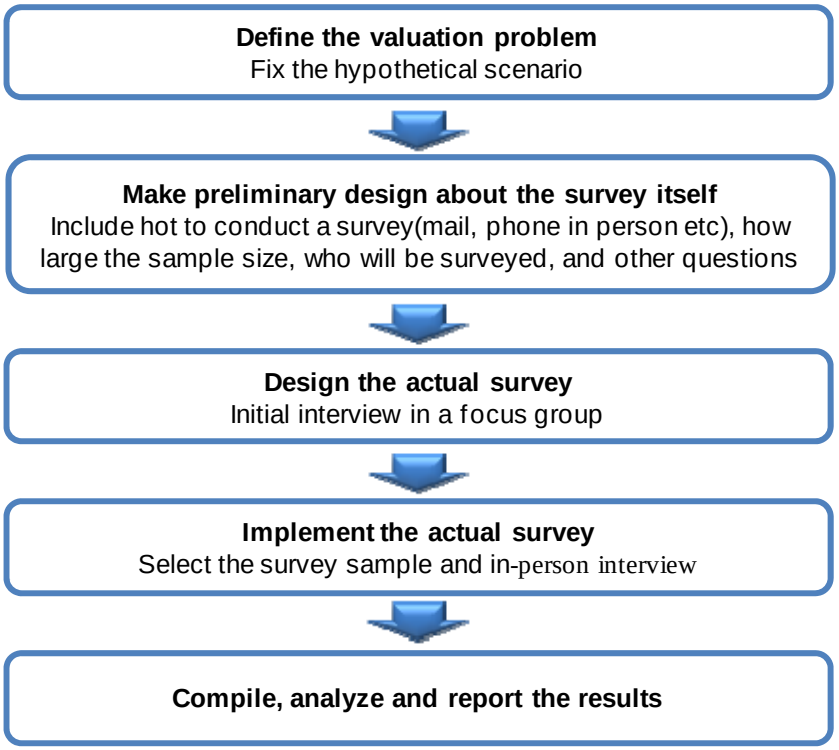


Figure 1 the process of application for CVM

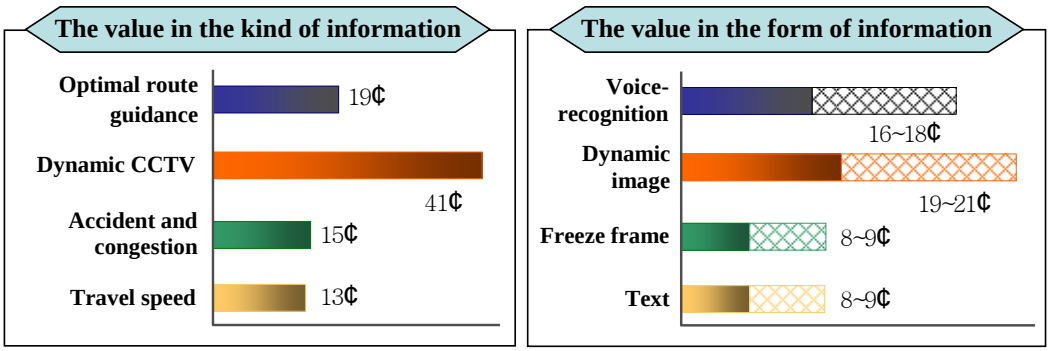
3. DESIGN OF QUESTIONNAIRE FOR CVM AND SURVEY

Questionnaire for CVM must be designed to minimize the controllable errors (for instance, starting point bias what is the greatest weaknesses of CVM etc), aside from unavoidable errors (such as stated preference (SP) bias). As the CVM results depend on how much is assumed the starting value and the successful survey, literature review to fix an upper limits and bottom line of starting point and In-person interviews were conducted.

Jun jung, Kim suggested that the value in the kind of expressway traffic information on navigation is estimated average about 22¢ (see Fig. 2). Navigation unit is a personal facility which provides the customized traffic information based on GPS tracking unlike VMS providing the public traffic information. The value of information on navigation is generally assumed higher than on VMS. This paper applied 22¢ to the upper limit of information on VMS.

Among the several methods, in-person interviews are generally the most effective for complex questions, especially in case of needs to explain background of survey or long survey. Thus

this paper conducted the survey of unspecified users who have ever experienced traffic information on VMS by the in-person interview to improve the reliability of research well.



1) Stated values are exchanged at the rate of 1,000 won to the U.S. dollar
2) All information are provided with the drivers in expressway.

Figure 1 the value of expressway traffic information on navigation

The conventional question fro WTP is phrased as “Are you willing to pay (WTP) to receive traffic information on VMS?” This paper designed the questionnaires as form of dichotomous-choice method. To help the rational judgment of respondents, the values related with other traffic information (through mobile or navigation etc.) were presented as an example.

In this paper, the hypothetical scenario made for CVM is as follows; the government plan to expand the scale (e.g. Interval between facilities etc) of VMS because VMS facilities are directly linked to user satisfaction of ITS service. At this time to make need budget, the government is considering charging a user fee for traffic information on VMS.

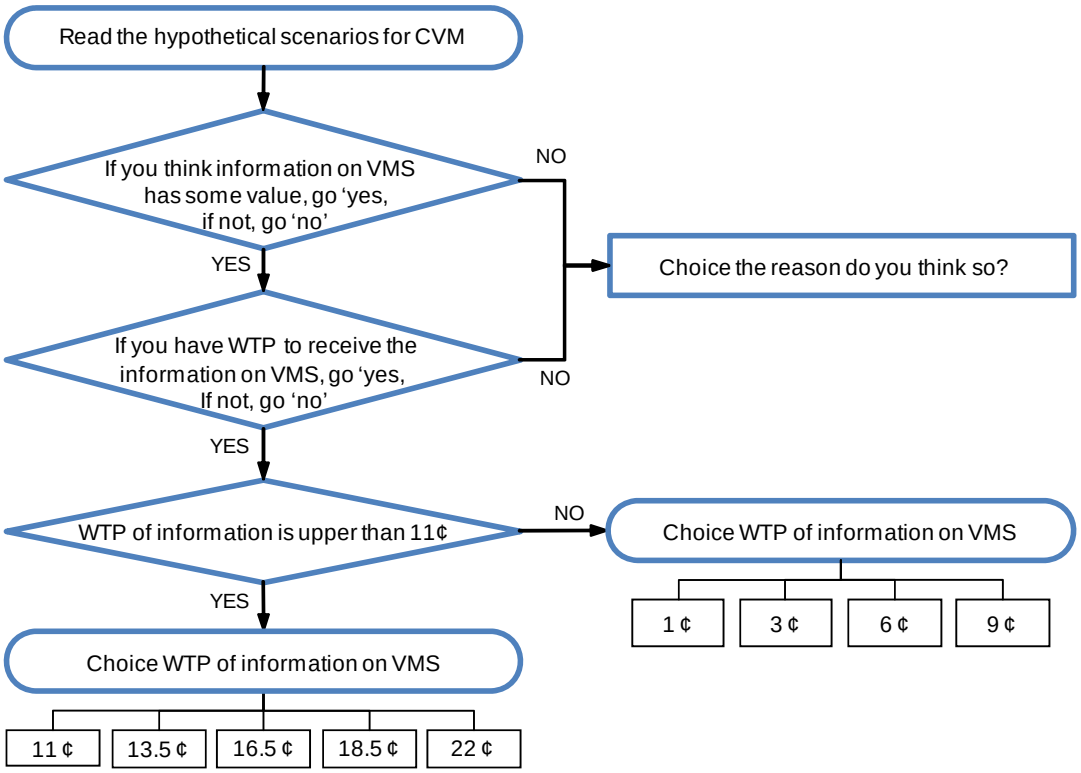
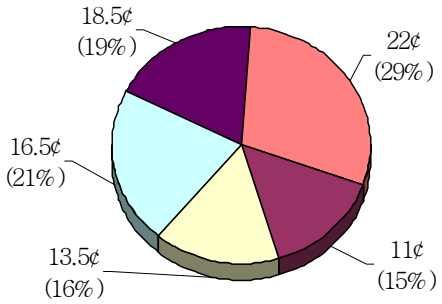


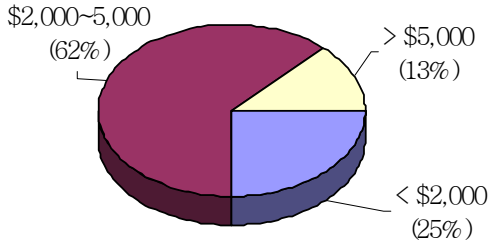
Figure 2 the flowchart of Questionnaire for CVM

The 387 valid questionnaires are collected. Among these, 74% is male and 26% is female. In age, 64% of total is between 30 and 49 age and 35% is 20~29age. In surveying the frequency using a car, 37% of respondents answer to use a car over 5 days in a week, 26% use a car 3~4days in a week, 25% don't use a car in a week. The survey shows that 63% of the whole respondents use a car over 3 days in a week. The 89% of respondent made an answer the real-time traffic information on VMS is valuable. Only 57% among them answered that traffic information is higher than 11¢ and the others answered that traffic information is lower than 11¢. The reason why information on VMS has no value is as follows; because of the wrong information (39%), because of no experience making use of information (29%), because of not wanting information (25%) and etc. In regarded to usable method for real-time traffic information, the survey result indicates that people prefer to use VMS in a road (33%) rather than private goods (15%) such as a cellular phone, PDA, ARS and otherwise.

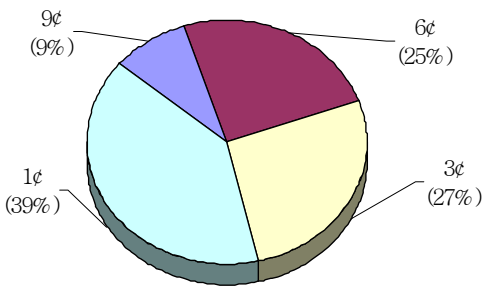
There are generally difference between the amount that people are actually willing to pay and the value of traffic information that people recognize. The 66% of the whole respondent, who they think that the value of VMS information is lower than 11¢, would prefer to pay 1¢ to 3¢ for the value of the real-time traffic information like as Table 1. Also the survey showed that the value of traffic information on VMS don't entirely depend on the income. The respondents whose monthly income is classified as a $2,000 ~ 5,000 group valued highly traffic information on VMS rather than other income group.[2]

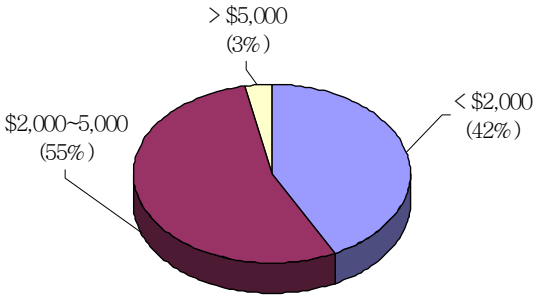
Table 1 Comparison between individual WTP for traffic information on VMS and monthly income





<The respondents who are willing to pay for upper than 11¢ and their monthly income>





<The respondents who are willing to pay for lower than 11¢ and their monthly income>

[2] The questionnaire data used in this paper come from the project KRIHS conducted in 2008. The name of project is "Effectiveness analysis and the demand-prospects for establishing the national highway ITS master plan".

4. ESTIMATION METHOD OF THE VALUE OF TRAFFIC INFORMATION ON VMS AND RESULTS

According to above survey results, the value of traffic information on VMS is appeared to be well worth enough. In this section, the analytical method for CVM data is reviewed and approximately estimated WTP for information on VMS is introduced.

CVM mainly discussed up to now is a method to gain the data appropriate for WTP estimation and the method analyzing the data for WTP estimation should be additionally reviewed. Methods analyzing CVM data are not only various according to type of model (such as linear regression, multinomial logit etc), but also are various along the probability distribution of population (e.g. weibull, exponential, log-logistics, gompertz etc). Thus it is substantially necessary to previously determine what model (linear or non-linear) to use and what probability distribution to assume. As distribution of the population is unknown in many cases, assumption for this is needed.

CVM data surveyed by dichotomous choice are censored by the amount of WTP and comes to be the survival function form in mathematics [12]. Thus this paper estimated WTP for the traffic information on VMS by applying survival function. The data classified by income and the demand curve for this study is each like as Table 2 and Figure 6.

Table 2 the survey data classified by income

WTP (unit : won)	Respondent rate(%) at Income			Total rate (%)
	< $ 2,000	$ 2,000 ~ 5,000	> $ 5,000	
10	8.4	9.0	0.6	18.0
15	1.7	4.1	-	5.8
30	5.8	7.5	0.6	13.9
60	6.1	6.7	0.9	13.6
90	1.7	3.2	-	4.9
110	8.1	15.7	0.3	24.1
135	0.6	2.3	0.6	3.5
160	2.0	2.3	0.6	4.9
185	1.2	2.6	0.3	4.1
200	0.9	4.9	1.4	7.2
Total	36.5	58.3	5.2	100.0

* stated values are exchanged at the rate of 1,000 won to USD for convenience´ sake

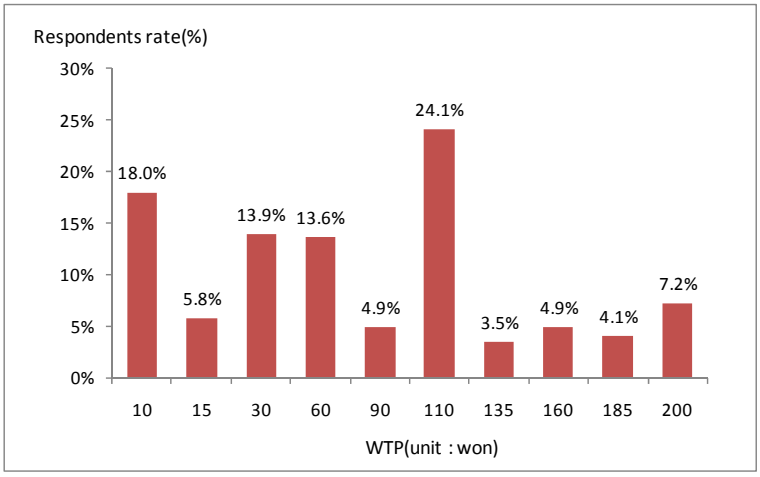


Figure 4 the Respondents rate for WTP on VMS information

This paper denoted the WTP function as follows,

$$\textit{the average WTP} = f(\textit{gender}, \textit{age}, \textit{vms}, \textit{income}, \textit{self\_dr}, \textit{fre\_dr}, \textit{info\_use})$$

where *vms* is the satisfaction indicator for the information provided through VMS, *self_dr* is whether to drive a car himself or herself, *fre_dr* is the frequency to drive in a week, *info_use* is whether to experience any information service.

The analysis result indicates that traffic information which is offered by one VMS has the value about 6¢ for each driver. But only *vms*, *income*, *fre_dr* among variables analyzed to be statistically significant and WTP is dependent on satisfaction for VMS. *Info_use* don't affect WTP for VMS information against our expectation. Probability distribution of population is assumed to be weibull.

Table 3 the analysis result

variable	coefficient	Std. deviation	t-value	P-value
Gender	-0.00984827	0.122769	-0.080218	0.936064
Age	-0.0922291	0.0795172	-1.15986	0.246104
*Vms**	0.206005	0.0820022	2.51219	0.0119985
*Income***	0.00101507	0.000577087	1.75895	0.0785857
Self_dr	-0.243641	0.238199	-1.02285	0.30638
*Fre_dr***	0.155739	0.0922844	1.6876	0.0914885
Info-use	0.0331365	0.100806	0.328716	0.74237
Constant	3.75175	0.231686	16.1933	2.88658e-0.15
Distribution of population	weibull distribution			
log-likelihood	-464.9754			
WTP(unit : ¢)	6.374			

"*" : the variable is statistically significant at 95% confidence interval
"**" : the variable is statistically significant at 90% confidence interval

5. CONCLUSION

The value of real-time traffic information on VMS has been never estimated unlike the already-marketed information on navigation because it has been generally regarded as free charge service though we already pay the related tax in anyway.

This paper introduced the value of traffic information on VMS as the new benefit which can judge the economic feasibility on ITS business and coined the term '*Escape effect from vagueness*' to describe the benefits which drivers are able to gain through traffic information on VMS. *Escape effect from vagueness* may be embodied through the valuation of information.

The survey asked directly the respondents how much the real-time traffic information on VMS to presume its value. This method is just the Contingent Valuation Method (CVM). CVM is the most widely used method for estimating non-use values. It is also the most effective as the non-market valuation methods. This study designed the questionnaires as form of dichotomous-choice method using the bidding game and described the hypothetical scenario. Also to minimize the starting point bias of the greatest weakness of CVM authors set up 22¢ as the upper line of the value of VMS information. This value was the value of the marketed traffic information on navigation and mobile etc. estimated in related study.

The analyzed results based on the CVM showed that the real-time traffic information on VMS would be worth about 6¢ in value. The analytical results showed that there is a closely correlation between WTP and income. But this paper didn't analyze the spatial and temporal transferability of this result because of time constraints and other. The spatial and temporal transferability of the analyzed value of WTP is regarded to be interesting research theme and remains future subject.

In Korea there is no the clear and accurate guideline for the economic feasibility on ITS business. Thus hereafter cautious efforts are needed to make the guideline corresponded to the particular characteristic at ITS business to help the reasonable and persuasive decision-making for ITS business. This paper expects the monetary value of information on VMS would be included one among the various benefits at ITS business and this result would be useful to make the guideline.

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